

Claims

What is claimed is:

1. A method of entering a time out interval for an event in a storage area network, comprising:
 - identifying a time slot in a sequence of time slots to insert a time out event for the event in the storage area network;
 - determining if other events in the storage network already have corresponding other time out events in the time slot; and
 - inserting the time out event for the event in the identified time slot along with the other time out events corresponding to the other events in response to the determination.
2. The method of claim 1 wherein identifying the time slot for the time out event, further comprises:
 - determining a time interval between each time slot in the sequence of time slots; and
 - selecting the time slot at an offset in the sequence of time slots based upon a multiple of the time intervals and the corresponding time out interval.
3. The method of claim 1 wherein the time interval between each time slot is proportional to a hardware timer clock frequency.
4. The method of claim 1 wherein the sequence of time slots to insert a time out event is implemented using a singly linked circular queue data structure.
5. The method of claim 4 further including identifying a current time slot in the sequence of time slots using a top of queue identifier.
6. The method of claim 5 further comprising,
 - moving to a subsequent time slot by advancing the top of queue identifier to a subsequent entry in the singly linked circular queue data structure each time a time interval corresponding to the time between each time slot elapses.
7. The method of claim 1 wherein the inserting further comprises organizing the time out event for the event along with the other time out events for the other

events in the identified time slot in order of insertion using a doubly linked circular queue data structure.

8. The method of claim 7 wherein determining if other time out events are in the same time slot further comprises traversing the doubly linked circular queue associated with the time slot and attributing each entry in the doubly linked circular queue with at least one other time out event being monitored on the storage area network.

9. The method of claim 8 wherein an empty doubly linked circular queue associated with the time slot indicates that no other time out events in the storage area network are being monitored during that time slot.

10. A method of removing a time out event being monitored for an event in a storage area network, comprising:

receiving a request to remove the time out event corresponding to an event in the storage area network;

identifying a time slot in a sequence of time slots to remove the time out event for the event in the storage area network; and

removing the time out event for the event in the identified time slot while the other time out events and the other corresponding events continue being monitored.

11. The method of claim 10 wherein identifying the time slot for the time out event, further comprises:

receiving a time out event indicator corresponding to the selected time slot in the sequence of time slots and time out event originally selected based upon information stored in an event context.

12. The method of claim 10 wherein the sequence of time slots to insert a time out event is implemented using a singly linked circular queue data structure.

13. The method of claim 12 further including identifying a current time slot in the sequence of time slots using a top of queue identifier.

14. A method of monitoring time out intervals for events in a storage area

network comprising:

receiving a request to determine if one or more events in the storage area network have timed out;

identifying a set of events associated with a current time slot in a sequence of time slots;

determining if the identified set of events in the current time slot is empty;

removing one or more events from the identified set of events associated with the current time slot in response to the determination; and

notifying a time-out handler associated with each of the one more events removed from the time slot to perform appropriate time-out related processing.

15. The method of claim 14 wherein the received request occurs in response to the elapse of a time interval.

16. The method of claim 15 wherein the time interval is proportional to a hardware timer clock frequency.

17. The method of claim 14 wherein the current time slot in the sequence of time slots is identified using a top of queue identifier that advances to a subsequent time slot each time a time interval elapses.

18. The method of claim 14 wherein the set of events associated with a current time slot in a sequence of time slots is implemented using a singly linked circular queue data structure.

19. The method of claim 14 further including identifying a current time slot in the sequence of time slots using a top of queue identifier.

20. The method of claim 14 wherein removing the one or more events from the identified set of events further comprises traversing a doubly linked circular queue associated with the time slot and removing each event entry in the doubly linked circular queue due to the expiration of the time out interval for each event entry.

21. An apparatus of entering a time out interval for an event in a storage area network, comprising:

a processor capable of executing instructions;

a memory containing instructions when executed on the processor that identify a time slot in a sequence of time slots to insert a time out event for the event in the storage area network, determine if other events in the storage network already have corresponding other time out events in the time slot and insert the time out event for the event in the identified time slot along with the other time out events corresponding to the other events in response to the determination.

22. The apparatus of claim 21 wherein the instructions that identify the time slot for the time out event, further comprise instructions that determine a time interval between each time slot in the sequence of time slots and select the time slot at an offset in the sequence of time slots based upon a multiple of the time intervals and the corresponding time out interval.

23 ~~24~~. The apparatus of claim ~~24~~²³ wherein the sequence of time slots to insert a time out event is implemented using instructions that operate on a singly linked circular queue data structure.

24 ~~25~~. The apparatus of claim ~~24~~²³ further including instructions that identify a current time slot in the sequence of time slots using a top of queue identifier.

25 ~~26~~. The apparatus of claim ~~25~~²⁴ further comprising instructions that move to a subsequent time slot by advancing the top of queue identifier to a subsequent entry in the singly linked circular queue data structure each time a time interval corresponding to the time between each time slot elapses.

26 ~~27~~. The apparatus of claim ~~27~~²⁶ wherein the insert instructions further comprises instructions that organize the time out event for the event along with the other time out events for the other events in the identified time slot in order of insertion using a doubly linked circular queue data structure.

27 ~~28~~. An apparatus for removing a time out event being monitored for an event in a storage area network, comprising:

a processor capable of executing instructions;

a memory containing instructions when executed on the processor receive

a request to remove the time out event corresponding to an event in the storage area network, identify a time slot in a sequence of time slots to remove the time out event for the event in the storage area network and remove the time out event for the event in the identified time slot while the other time out events and the other corresponding events continue being monitored.

28 ~~28~~²⁷. The apparatus of claim ~~28~~²⁷ wherein the instructions that identify the time slot for the time out event, further comprise instructions that receive a time out event indicator corresponding to the selected time slot in the sequence of time slots and time out event originally selected based upon information stored in an event context.

29 ~~30~~²⁷. The apparatus of claim ~~28~~²⁷ wherein the instructions that use the sequence of time slots to insert a time out event is implemented with instructions that operate using a singly linked circular queue data structure.

30 ~~31~~²⁹. The apparatus of claim ~~30~~²⁹ further including instructions that identify a current time slot in the sequence of time slots using a top of queue identifier.

31 ~~32~~. An apparatus for monitoring time out intervals for events in a storage area network comprising:

a processor capable of executing instructions;

a memory containing instructions when executed on the processor receive a request to determine if one or more events in the storage area network have timed out, identify a set of events associated with a current time slot in a sequence of time slots, determine if the identified set of events in the current time slot is empty, remove one or more events from the identified set of events associated with the current time slot in response to the determination and notify a time-out handler associated with each of the one more events removed from the time slot to perform appropriate time-out related processing.

32 ~~33~~³¹. The apparatus of claim ~~32~~³¹ wherein the instructions receive the request in response to the elapse of a time interval.

33 ~~34~~³¹. The apparatus of claim ~~32~~³¹ wherein the instruction that identifies the

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current time slot in the sequence of time slots uses a top of queue identifier that advances to a subsequent time slot each time a time interval elapses.

34³⁴ 35. The apparatus of claim ³⁴32 wherein the set of events associated with a current time slot in a sequence of time slots is implemented using instructions that operate on a singly linked circular queue data structure.

35³⁵ 36. The apparatus of claim ³⁵32 wherein the instructions that remove the one or more events from the identified set of events further comprises instructions that traverse a doubly linked circular queue associated with the time slot and removing each event entry in the doubly linked circular queue due to the expiration of the time out interval for each event entry.

36³⁶ 37. An apparatus for entering a time out interval for an event in a storage area network, comprising:

means for identifying a time slot in a sequence of time slots to insert a time out event for the event in the storage area network;

means for determining if other events in the storage network already have corresponding other time out events in the time slot; and

means for inserting the time out event for the event in the identified time slot along with the other time out events corresponding to the other events in response to the determination.

37³⁷ 38. An apparatus for removing a time out event being monitored for an event in a storage area network, comprising:

means for receiving a request to remove the time out event corresponding to an event in the storage area network;

means for identifying a time slot in a sequence of time slots to remove the time out event for the event in the storage area network; and

means for removing the time out event for the event in the identified time slot while the other time out events and the other corresponding events continue being monitored.

38³⁸ 39. An apparatus for monitoring time out intervals for events in a storage area

network comprising:

means for receiving a request to determine if one or more events in the storage area network have timed out;

means for identifying a set of events associated with a current time slot in a sequence of time slots;

means for determining if the identified set of events in the current time slot is empty;

means for removing one or more events from the identified set of events associated with the current time slot in response to the determination; and

means for notifying a time-out handler associated with each of the one more events removed from the time slot to perform appropriate time-out related processing.